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In an earlier paper (Miller, 1971) I described the mealybug fauna of Santa Cruz Island, and discussed the California Island biota, including brief statements on island name terminology, endemism, and disjunctions.

In July 1970 I collected on San Miguel Island for nine days. Although this was far from an adequate amount of time to collect specimens of each mealybug species on the island, I think it was sufficient to permit me to adequately compare the origins and relationship of the pseudococcid faunas of San Miguel and Santa Cruz Islands.

San Miguel is approximately 14 square miles in land area, is 26 miles from the nearest point on the mainland, is three miles from the nearest island (Santa Rosa), and is 21 miles from Santa Cruz Island (Philbrick, 1967). The highest elevation, 831 feet, is on San Miguel Mountain. The general topography of the island has been described by Bremner (1933) as follows: "Most of the surface of the island is a wave-cut terrace from 400 to 500 feet in elevation above which rise two hills. . . . (San Miguel and Green Mountains). . . . A lower terrace from 20 to 100 feet in elevation borders the south coast. . . . The island has been eroded but little since the terraces were cut. Two streams heading on the flanks of Green Mountain and flowing northward and southward respectively, have cut deep narrow canyons. . . . Another steep narrow canyon heads on the terrace near the ranch house and drains northward to Cuyler Harbor. The island when first visited by Europeans, was covered with a dense growth of brush. . . . Cattle and sheep were placed on the island. . . . and allowed to multiply without restriction, with the result that much of the vegetation was destroyed. The strong prevailing winds from the northwest then formed dunes of drifting sand that now cover most of the surface." Sand beaches are common and surround about ¾ of the island. The only trees are several recently introduced palms. The flora contains no taxa which occur exclusively on San Miguel, although there are nine plant species, subspecies, or varieties which have been recorded on San Miguel and at least one other California Island but are not known on the mainland (Raven, 1967). The herpetofauna includes one salamander and two lizards, none of which

are insular endemics (Savage, 1967). The terrestrial mammal fauna consists of a bat, an endemic subspecies of deer mouse, and an endemic race of gray fox. The fox species is an insular endemic (von Bloeker, 1967). Marine mammals are abundant on the beaches and off-shore waters of San Miguel. In recent years four or five species of seals and sea lions have been reported (Bartholomew, 1967) in addition to the sea otter (Allanson, 1955). A general study of the insect and bird faunas of San Miguel has not been published to my knowledge.

The recent geologic history of the California Islands is not well understood. San Miguel apparently was last submerged during the First Interglacial period of the Pleistocene (Orr, 1967). The time of the last land connection to the mainland is not well established—late Pliocene to mid-Pleistocene (Orr, 1967), mid-Pleistocene (Valentine and Lipps, 1967), or late Pleistocene and sub-Recent (Weaver and Doerner, 1967). All seem to agree that if a connection actually occurred, it was as a peninsular extension of the Santa Monica Mountains. After the last continental land connection, there is evidence that San Miguel was joined to the other Northern Channel Islands at least during the late Pleistocene (Valentine and Lipps, 1967).

SAN MIGUEL ISLAND MEALYBUGS

The following list includes 12 genera and 13 species. The localities may be found on the accompanying map (Fig. 1). Plant names are as listed by Munz and Keck (1965). The only previous mention of a mealybug on San Miguel was by Cockerell (1938) who stated, "A kind of mealy-bug, perhaps new, was found on *Astragalus miguelensis*." The unnamed mealybug was most likely *Pseudococcus obscurus*.

*Amonostherium**lichtensioides* (Cockerell)

1. Green Mountain, 11 July 1970, *Artemisia californica* (foliage)
2. Harris Point, 10 July 1970, *A. californica* (foliage)

*Chorizococcus**abroniae* McKenzie

1. Cuyler Harbor, 12 July 1970, *Franseria* sp. (decumbent branches)

*Distichlicoccus**salinus* (Cockerell)

1. Bay Point, 12 July 1970, *Distichlis spicata* (on leaf blade)
2. Cuyler Harbor, 9 July 1970, *Distichlis spicata* (on leaf blade)

*Heterococcus**arenae* Ferris

1. San Miguel Mountain, 11 July 1970, grass (in leaf sheath)



FIG. 1. San Miguel Island mealybug collection sites 1. Bay Point 2. Cuyler Harbor 3. Green Mountain 4. Harris Point 5. San Miguel Mountain 6. Simonton Cove 7. Ranch south of Cuyler Harbor.

Paludicoccus

distichlium (Kuwana)

1. Cuyler Harbor, 9 July 1970, *Distichlis spicata* (in leaf sheath)

Phenacoccus

colemani Ehrhorn

1. Harris Point, 10 July 1970, *Dudleya* sp. (on roots)

gossypii Townsend and Cockerell

1. Simonton Cove, 10 July 1970, *Haplopappus* sp. (on foliage)

Pseudococcus

obscurus Essig

1. Bay Point, 12 July 1970, *Coreopsis gigantea* (on roots)
2. 1 mi. S. Bay Point, 12 July 1970, *Astragalus* sp. (on roots)
3. Cuyler Harbor, 12 July 1970, *Coreopsis gigantea*, *Eriogonum* sp., *Franseria chamissonis* (on roots)
4. Green Mountain, 11 July 1970, *Lotus* sp., *Mesembryanthemum* sp. (on roots)
5. Ranch S. of Cuyler Harbor, 9 July 1970, *Astragalus* sp., *Baccharis* sp., *Lupinus* sp. (on roots)
6. San Miguel Mountain, 11 July 1970, *Mesembryanthemum* sp. (on roots)
7. Simonton Cove, 10 July 1970, *Abronia* sp., *Astragalus* sp., *Eriogonum* sp. (on roots)
8. 0.5 mi. S. E. Simonton Cove, 10 July 1970, composite (on roots)

Puto

yuccae (Coquillett)

1. Bay Point, 12 July 1970, *Atriplex semibaccata* (on roots)

2. Cuyler Harbor, 9 and 10 July 1970, *Abronia* sp., *Atriplex semibaccata*, *Eriogonum* sp., *Mesembryanthemum* sp. (on foliage)

Rhizoecus

gracilis McKenzie

1. Bay Point, 12 July 1970, composite (on roots)

Spilococcus

keiferi McKenzie

1. Cuyler Harbor, 9 July 1970, *Eriogonum* sp. (on foliage)

Tridiscus

distichlii Ferris

1. San Miguel Mountain, 11 July 1970, *Distichlis spicata* (in leaf sheath)

Trionymus

smithii (Essig)

1. Green Mountain, 11 July 1970, grass (in leaf sheath)
2. 0.5 mi. S. E. Simonton Cove, 11 July 1970, grass (in leaf sheath).

DISCUSSION

Based on the work of McKenzie (1967) there are approximately 40 species of mealybugs which have been collected on hosts that occur on San Miguel Island and are found in the coastal mainland areas adjacent to the Northern Channel Islands. Of the 40 species, only 13 have been collected on San Miguel. Three of the 13 are distributed throughout most of California, three occur in saline regions along the coast, two occur in the coastal mountain ranges and beaches, two in the coastal ranges, southern deserts, and Sierra-Nevada Mountains, two in the coastal ranges and the Sierra Nevada, and one exclusively on beaches. All mealybug species that occur on San Miguel very probably are present in the coastal mountains or beaches of the immediate California mainland. It is therefore likely that the San Miguel pseudococcid fauna is a depauperate aggregation of mealybug species which are closely allied to the adjacent mainland fauna. Based on these assumptions, it is logical to conclude that San Miguel has been colonized from the adjacent California mainland via the other Northern Channel Islands.

Perhaps the most interesting aspect of the San Miguel mealybug fauna is displayed by *Pseudococcus obscurus*. This species was encountered in great abundance at nearly every collecting site. Although it is a common California mealybug, I have never before seen it in such numbers or in so many different kinds of habitats as on San Miguel. Although it is tempting to suggest that this expanded insular diversity is caused directly by the availability of vacant feeding sites, alternative explanations such as lack of natural enemies are possible.

COMPARISON OF THE MEALYBUG FAUNAS OF SAN MIGUEL AND SANTA CRUZ ISLANDS

There are several noticeable differences in the Santa Cruz and San Miguel mealybug faunas. (1) The Santa Cruz fauna contains nearly twice as many mealybug species as that of San Miguel. Of the 13 species present on San Miguel, only two are unrecorded on Santa Cruz, whereas of the 23 species on Santa Cruz, 12 are unknown on San Miguel. The reason for these differences seems evident since Santa Cruz is larger in size, is closer to the mainland, has a greater habitat diversity, and apparently has been continuously emergent for a longer period of time. (2) Although Santa Cruz supports a much larger number of pseudococcid species, individuals are relatively rare. On San Miguel however, the species number is small, but individuals, particularly of *Pseudococcus obscurus*, are abundant. Furthermore, on Santa Cruz there is no evidence of unusual ecological diversity, but on San Miguel *P. obscurus* is not only exceptionally abundant, but also occurs on many previously unrecorded hosts. These differences very possibly are unrelated to insular phenomena. Many pseudococcids prefer sandy, well drained soils, particularly those species that occur in the moist coastal regions. On Santa Cruz this type of habitat is present but uncommon, whereas on San Miguel nearly the entire island is covered by sand. Presumably, once an oligophagous species such as *P. obscurus* has successfully colonized San Miguel and has adapted to a sandy habitat, it can easily spread and become abundant. On Santa Cruz once an oligophagous species has become established, in order to successfully inhabit large geographic areas, it must adapt not only to many hosts, but also to varied types of habitats, many of which are not very successfully colonized even on the mainland. (3) On Santa Cruz, there are five pseudococcid species which do not occur on the closest mainland but do occur farther north in California. On San Miguel no disjunctions were found; all species apparently occur on the adjacent mainland. (4) On Santa Cruz the genus:species ratio was about 1:2; on San Miguel the ratio was approximately 1:1.

There are two similarities in these insular faunas. (1) Both lack the endemic taxa encountered in other parts of their respective biotas. (2) Both are depauperate aggregations of species similar to the pseudococcid fauna on the adjacent mainland.

SUMMARY

Twelve genera and 13 species of mealybugs are known on San Miguel Island, none of which are endemic. The pseudococcids comprise a de-

pauperate aggregation of species similar to the mealybug fauna of the adjacent mainland. One species, *Pseudococcus obscurus*, appears to be much more abundant and to occupy more diverse habitats on San Miguel than on the mainland or on Santa Cruz Island.

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